SEPTEMBER 12, 1983

CHEMICAL & ENGINEERING

NEWS

Candidates in ACS fall election:
Their views and backgrounds
Page 54

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Dioxins and dibenzofurans New chemical findings

Page 26

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News of the Week

■ **Economists predict the recovery will proceed steadily, auguring well for chemicals.** **Page 6**

■ **House bloc opposing binary chemical weapons production may stall Defense funding.** **Page 7**

■ **Science academies of the U.K., Norway, and Sweden set up acid rain research study.** **Page 7**

Business

Chlor-alkali makers face continued overcapacity, low growth, thus permionic membrane technology will be used sparingly. **Page 9**

International

Enzymes business has lured some large chemical, biotechnology firms; U.S. chemical trade surplus expected to continue. **Page 11**

Government

Symposium discusses successes, failures of patent law changes; another probes federal agencies' use of risk assessment. **Page 22**

Science

From the ACS meeting: survey on public perceptions of science; good look at surface chemistry; computers and carbenes. **Page 28**

Education

Holistic approach to teaching analytical chemistry would stress the problem as well as the sample, educator says. **Page 37**

Technology

Also from the meeting: charm of microemulsions; optimizing use of energy; new kinds of catalysts; supercritical extraction. **Page 41**

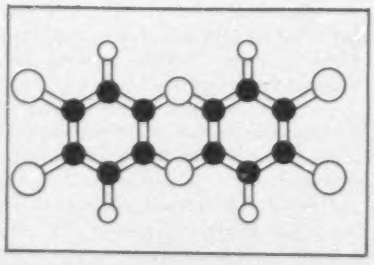
ACS Election

Candidates for 1984 ACS president-elect, regional directors, and director-at-large present their platforms. **Page 54**

Letters 4

Concentrates
Business 8
Government 16
Science/Technology 25

The Departments
Meeting Briefs 48
ACS News 50
Newscripts 88



Cover Story

Several studies carried out to determine health effects of dioxins and dibenzofurans reported at meeting. **Page 26**

Chlor-Alkali Companies Plagued by Low-Growth Outlook

Many firms can't fund needed investments because of poor profits, but will use newer membrane technology for incremental plant expansions

Washington, D.C.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Hard-pressed chlor-alkali companies, reeling from such body blows as overcapacity, low operating rates, a poor profit picture, and low growth projections, will have problems generating enough earnings to fund the investments that will be needed in the future.

Technology will play a key role in their efforts, Paul J. Kienholz, chlor-alkalies business manager for PPG Industries, told the Chemical Marketing & Economics Division. But he doesn't see a significant trend toward using the new and highly touted permionic membrane technology in new, small captive plants in the U.S. Instead, he thinks that some of the lean and mean companies that survive in the chlor-alkali business will use membrane cells for incremental expansions that would more closely match growth in demand.

Kienholz says that this type of installation does not require the typically large replacement costs. "It will be easier to justify," he says, "and this is where I believe that membrane technology will be used most effectively."

Justifying any investment right now is difficult for chlor-alkali companies. Profits are down, and with low growth rates and low operating rates ahead, the future isn't especially encouraging.

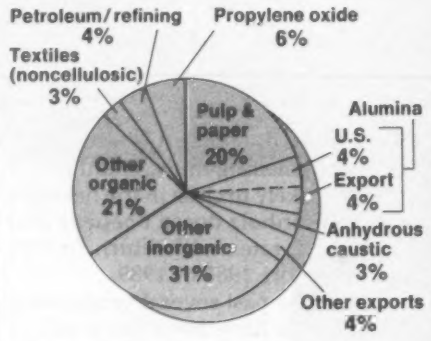
Throughout the 1950s and 1960s, chlorine growth rates of 7 to 9% annually were common. In the 1970s, 2%-per-year rates were typical. At one time, the ratio of chlorine growth to GNP growth was 2.6; in the seventies, it was more like 0.5.

What stunted chlorine's growth, Kienholz says, was a variety of environmental and toxicological developments, as well as some changes in processes that consume chlorine. Several economic recessions didn't help.

Over the next 10 years, Kienholz estimates that chlorine demand will increase at a 2.7%-per-year average clip. The first half of the decade will be stronger—about 3% per year—but this will dip slightly to about 2.5% annually between 1987 and 1992.

For the 1.1 tons of caustic soda that is coproduced with chlorine, future growth rates are in the same ball park. Over the next 10 years, Kienholz has caustic demand growing an average 3% per year, again stronger in the first five years than in the last five.

Caustic soda has diverse markets



Total 1982 use = 9.2 million tons

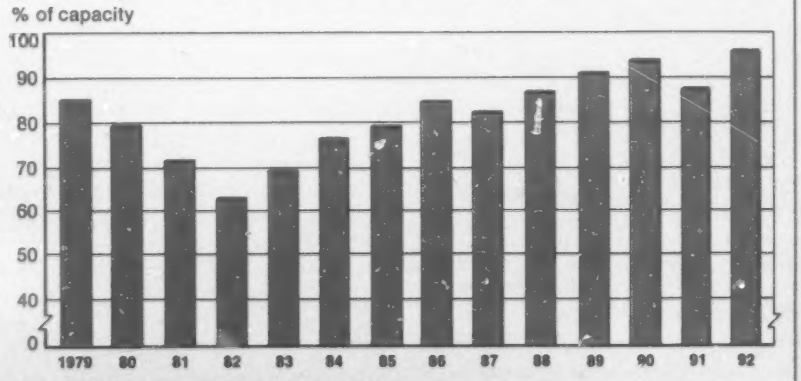
Source: PPG Industries

At those rates, companies should be able to manage chlorine-caustic imbalances easily, says Kienholz. The traditional route is to replace caustic with lime and soda ash.

A more serious problem, however, is plant operating rates. Historically, the chlor-alkali industry often has run at 95% of capacity or better.

Since the 1975 recession, however, operating rates below 80% have been

Chlorine operating rates: no 90% of capacity until late 1980s



Note: 1983 and on are forecasts. Source: PPG Industries

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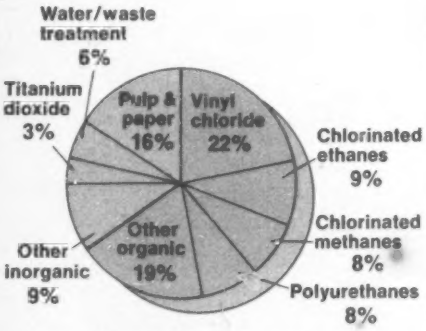
Vinyl chloride is big chlorine user



Total 1982 use = 9.2 million tons

Source: PPG Industries

the rule rather than the exception. Even after taking into account plants that are likely to close in the next five years, Kienholz doesn't believe that operating rates will return to 90% levels before 1988 or 1989.

Over the past several years, plant shutdowns have been the order of the day. Between 1970 and 1981, about 15 plants, with more than 3000 tons per day of chlorine capacity, were shut down permanently. The 1981–82 recession has had a brutal impact on the industry. Last year alone, plants with more than 2800 tons per day of capacity were closed, either permanently or temporarily.

Kienholz believes that, over the next few years, an additional 4200 tons per day will be shuttered. All of this adds up to a loss of more than 10,000 tons per day for an industry whose capacity has ranged from 28,000 to 40,000 tons daily.

As a result, Kienholz says that the industry is entering "an unprecedented era" in which low growth in capacity will occur over longer periods of time than ever before. The survivors, he says, will be those who are cost-competitive. This means being efficient with energy, capital, and people.

Another key will be large plants that provide economies of scale, he says. New plants will not be in the picture. For the most part, smaller incremental expansions using membrane cells at existing units will be the norm. Environmental concerns and power requirements rule out mercury cells.

Permionic membrane technology is advancing swiftly, so swiftly that a legitimate concern is that a plant may be outdated a few years after it comes on stream. But there is one overriding factor influencing the choice and use of technology in U.S. chlor-alkali plants, Kienholz says. Today, more than 75% of U.S. chlorine capacity remains in diaphragm cells. Much of this capacity is in large-scale plants that have been modernized in the past five years and are extremely energy-efficient. Equally important, these plants were built at capital costs that can't be approached today.

In addition, many of these units have highly efficient power sources in their own combined-cycle gas turbine investments. For economic reasons, Kienholz says, they would be difficult to idle.

Factors such as these put a limit on how new chlor-alkali technology can be used in the U.S. Kienholz thinks that by the end of the decade diaphragm cell units still will account for a large share of total capacity.

There also is the demand outlook to consider. Although he sticks by his 2.5%-per-year estimate, Kienholz says that a 1.3% rate is not out of the question. That's what it has been since 1968. "How many of us will be willing to invest in a business that offers only between 1- and 3%-per-year growth rates based on uncertain assumptions?" he asks. In addition, prototype membrane cells that have been operating for more than a year have pushed energy requirements down another 30%. It is difficult to justify building a completely new membrane unit based on today's technology, says Kienholz, when that technology could require 35 to 40% more energy than a technology that might be just around the corner.

Where does this leave the companies that might survive in the chlor-alkali business? In an excellent position, Kienholz says, because they can take optimum advantage of these developments with minimum risk.

Many major producers with large plants generate their own power. Some have their own cogeneration systems; others are considering them. The large diaphragm plants are cost-competitive with new membrane cells because their capital is based on 1970 construction costs. Most of them can operate in the same energy range and they enjoy economies of scale.

They have operations that provide ultrapure salt to feed membrane cells. They also are capable of incrementally and inexpensively increasing caustic soda evaporation capacity to accommodate additional cell liquor from a membrane cell.

All of this, Kienholz says, means that these plants can take advantage of incremental economic situations as they develop, using membrane cells to make incremental expansions that closely match incremental increases in demand. This, he says, is how membrane technology will be used in the U.S.

Not only can companies take advantage of today's membrane technology, they also can be in a position to step into futuristic technology in the late 1980s or early 1990s. This technology includes membrane cells that use oxygen- (or air-) depolarized cathodes to lower power levels to about 1600 kwh per electrochemical unit.

Kienholz believes that, used properly, technology will play a key role in helping U.S. chlor-alkali companies become stronger and better able to serve their customers for the remainder of the 1980s. The hitch is that there will be fewer companies. □

U.S. chlorine plant shutdowns will continue

	Capacity (tons per day)
1970–81	
Various[a]	3,125[a]
1982	
Dow Chemical, Midland, Mich.	800[b]
Occidental, Taft, La.	685[b]
Montague, Mich.	225[b]
LCP, Linden, N.J.	425[b]
Olin, McIntosh, Ala.	350[b]
Pennwalt, Calvert City, Ky.	330[a]
Champion International, Pasadena, Tex.	60[a]
1983 and beyond	
PPG Industries, Barberton, Ohio	340[a]
BASF Wyandotte, Geismar, La.	820
Various potentials	2,890
TOTAL	10,050

a Permanent shutdown. b Temporary shutdown. Source: PPG Industries

Enzymes Business Attracting New Producers, Technology

Several large chemical firms have entered the merchant market; recent advances in biotechnology promise to improve production methods

Patricia L. Layman, C&EN London

For an industry that goes back even beyond biblical times, the enzymes business is taking on some traits characteristic of the modern chemical industry. It is seeing an increasing emphasis on specialty products. It is seeing an increasing interest among producers in the potential of the latest developments of biotechnology. And more and more it is seeing the entry of large chemical companies willing to bankroll a marketing effort to break the hold of the companies that historically have dominated the business.

Enzymes add up to about $390 million in worldwide sales, up from an estimated $300 million in 1979. It is a highly stratified business. Two suppliers—Novo Industri of Copenhagen, Denmark, and Gist-Brocades, of Delft, the Netherlands—account for about 65% of total worldwide sales, and another seven companies contribute about 17% of total sales.

On the other side, most of the enzymes business is made up of sales of only 16 enzymes, out of the hundreds identified. One class, starch conversion enzymes, constitute about 40% of the total, with three—amylase, glucose isomerase, and amyloglucosidase—the main ones. Detergent proteolytic enzymes account for another 30%, with the remainder of the market split among a dozen other different products.

Those are some of the conclusions

Hepner: highly stratified business

one could draw from a recently completed study of the enzymes business, conducted by Leo Hepner and Celia Male of chemical consulting firm L. Hepner & Associates, London.

Fortunately for the industry, however, the two largest categories of products, starch conversion and detergent enzymes, are both relatively fast-growing businesses, according to Hepner and Male. They each will see real-volume growth of about 5% per year over the next five years, the two consultants predict.

Of the two enzyme types, detergent enzymes probably have more potential for continuing good growth. Although the market for enzymes in detergents is fairly well satisfied in Europe, market penetration is still low in most of the rest of the world. For example, in the U.S., enzyme producers still are recovering from the great debacle of more than a decade ago, when worker-safety questions, since resolved, pushed detergent makers into dropping enzymes from formulations. At that time, presoak products were promoted widely, but now manufacturers quietly are adding them to formulations to boost efficacy and performance.

Starch-conversion enzymes, on the other hand, will continue to hold onto the largest portion of the enzymes market and will continue to grow in sales, but the dramatic growth of the past several years will begin to settle down. Growth will continue in the U.S., of course, but the market already is close to being saturated for high-fructose corn syrup, and has slowed temporarily for production of alcohol for gasohol. Other geographical areas are not nearly so promising.

For example, a sizable potential market for starch-conversion enzymes in Brazil never did pan out. Marketers figured they would be selling enzymes to convert cassava-derived starch to sugar for fermentation to alcohol for Brazil's fuel program. But the supplies easily fermented to alcohol without enzymes.

And in the other market whose size is equivalent to the U.S.—Europe—use of starch-conversion enzymes has been blocked artificially by the twists and turns of European Economic Community quotas. The quotas severely limit high-fructose corn syrup production on several points.

Such syrup would be derived from corn, imported from Canada and the U.S., and would compete directly with the sugar beets grown in Europe where, among its other food-surpluses, there is a "sugar mountain." There are several small plants for making high-fructose corn syrup. But output throughout EEC is rationed to a total of just over 200,000 tons per

year, Male points out. In the U.S., with a comparable population, output is approaching nearly 4 million tons per year.

Other parts of the world, however, will help contribute to the growth of starch-conversion enzymes. Pfizer, for one, has decided there is promise in South America, and it has made a commitment for making the enzymes there. Japan is increasing its use of starch-based sweeteners, and Thailand is turning its manioc into sweeteners. For better or worse, the developing nations are turning to processed foods and such sweeteners are an integral part of the processed foods industry.

A few enzyme markets are flat or growing too slowly to be of much interest to anyone other than those already in the business—enzymes for textile desizing, for example, or for leather-bating. Other areas are more buoyant, with sales growing for rennet, for instance, used in cheese making, because cheese consumption is rising.

But other areas are somewhat less promising for the near future. Hepner and Male see little future in cellulose enzymes, over the next five years, for breaking down waste cellulose for glucose. Perhaps most important, there would be a stigma against using the resulting product in foods. And other potential uses—for further conversion to industrial alcohol, perhaps—are limited by unfavorable economics owing to relatively high costs of collecting and processing what otherwise would be cheap raw materials.

Similarly, lactase faces a sluggish near term, although sales will "chug along," says Hepner. There is potential for its use to upgrade whey fractions and lactose, hydrolyzing them to glucose and galactose syrup. But at present, neither price nor availability has given manufacturers any incentive to turn from their present course of condensing and drying whey and whey fractions for animal feed.

However, there are enough areas of growth to entice new producers into the business or convince present producers to expand into other markets. Pfizer's decision to enter the starch-conversion enzymes market in Brazil adds to its production in Mexico of detergent enzymes. It has kept up production there, although it ceased production in the U.S.

Enzyme industry shapes up this way for producers . . .

	$ Millions
Novo Industri	$145
Gist-Brocades	105
Seven other firms	70
20 remaining firms	70
TOTAL	$390

. . . and for products

	% of total market
Starch conversion[a]	40%
Detergent enzymes	30
Miscellaneous, about 12	30

a Amylase, glucose isomerase, and amyloglucosidase.
Source: L. Hepner & Associates (London)

One of the most recent to enter the merchant market is CPC International. CPC is a major captive user of enzymes, particularly starch conversion enzymes for its corn syrups, and the company often sold excess to the merchant market. But its decision to put up a U.S. plant (location undecided yet) signals a new commitment to the business.

Other captive producers are potential entrants into the business—ADM, for example, or distillers such as Hiram Walker and Seagram, or the French starch converter Roquette. In Finland, captive producer ALKO and Finnish Sugar Co., the state's alcohol producer, both are building small enzymes plants for the merchant market.

Coming in by another line of attack, Corning Glass and Genentech early in 1982 established the joint venture Genencor for marketing immobilized enzymes. The venture seeks to exploit Corning's technology for immobilizing the materials, while Genentech provides its recombinant DNA techniques for producing enzymes. The unit bought a small enzyme plant from Rohm & Haas to start up with.

How well the venture does remains to be seen. The major market that immobilized enzymes have found has been in production of high-fructose corn syrup. Immobilized glucose isomerase just fit the bill, and, indeed, probably made such production economically feasible. Beyond that, however, there are reservations held by at least some industry observers. "Biotechnology has been the buzzword in enzymes," says Hepner. "But while it may or may not affect the market eventually, it is not commercial now."

Genentech officials naturally are enthusiastic about the potential of using recombinant DNA to produce enzymes. The San Francisco-based Cindany already has taken aim at the market for rennet, a key enzyme in cheese making, now made by microbial fermentation or derived from calf stomachs.

"Rennet is getting in short supply," says a Genentech official. "There eventually will be a problem unless something else is done, especially as cheese consumption goes up." And other food processing and fine chemical enzymes may be approaching a similar supply situation, explaining rennet's marketing emphasis.

Genencor, the official says, will be able to use its technology "to look at novel enzymes," and to replace energy-intensive methods with its own, to produce "high-quality, low-cost ingredients." The device, the official adds, to find a more efficient way to produce very large quantities of enzymes is the major push for the enzymes business today.

Thus, how well biotechnology fits in remains unanswered. Although even traditional producers are hedging their bets—Chr. Hansen, based in Copenhagen, which probably has nearly 50% of the world market for rennet, has set up a marketing agreement with Genencor, for example—new manufacturers face a conservative and stable market that can be difficult to crack.

Rennet, for example, is a well-established market. And although cheese consumption is rising as people increasingly turn to cheese for a replacement for meat protein, more rennet per unit of cheese is not demanded. Growth is linked solely to growth of cheese.

"If a product made by recombinant DNA techniques is really identical to calf rennet, and much cheaper, cheese makers would change," says consultant Male. "But if it is the same price, they probably wouldn't bother."

Instead, the consultant predicts, established companies will try to keep ahead of the marketplace by developing specially tailored enzymes able to justify higher prices. Hepner cites, for example, Novo's recent introduction of a high-temperature amylase and a low-temperature rennet. The high-temperature amylase, which is patented, can be used under high processing temperatures for starch conversion.

Manufacturers therefore can devise continuous steam- or pressure-cooking conversion processes. Similarly, much of the rennet sold, derived from microbial fermentation, is not deactivated by pasteurization, so it can keep acting beyond the desired level during cheese making. Calf rennet is deactivated. Novo's new rennet, though microbially produced, also is deactivated by heat—it is thermally labile—so it won't continue activity longer than desired and degrade the cheese.

The key point for a manufacturer is "to look at the weaknesses of what is on the market now, and devise ways to improve upon them for customers," says Male—typical specialties marketing strategy. "The same product can be a specialty or a commodity depending on who makes it," adds Hepner. "You couldn't just come in with a me-too product, unless it was considerably cheaper. Then you are in the price-cutting business, and you are back to commodities again."

Manufacturers also must keep an eye out for new markets for unexploited enzymes. A case in point is pullulanase, for the brewing industry, which has become of interest because of the "light" beer phenomenon. If the excess carbohydrates left after regular brewing are removed or fermented to alcohol, fewer calories are in the beer, is the marketing claim that brewers such as Miller and Budweiser have used with good effect in the U.S., according to Hepner and Male. Pullulanase is "the ultimate method," when coupled with β-amylase. The two enzymes break down the branched-chain carbohydrates still left in the brew, which then can ferment into alcohol—and provide the brew that sets sports pitchmen into action, promoting the products. □

U.S. chemical trade surplus will continue

Washington, D.C.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Through the first half of the year, chemical exports were running about 6% behind their pace in 1982, but chemical imports were 14% higher than they were last year.

At these rates, the U.S. chemical industry could end up the year with a trade surplus of only $8.9 billion. In 1982 that surplus was $10.4 billion, and only three years ago it stood at a record $12.1 billion.

Because of developments such as these, chemical trade has taken a beating in the press as well as in the marketplace, says Karl D. Loos, a senior staff member in the chemical industry section at consultant firm Arthur D. Little Inc., Cambridge, Mass. Suggestions that the U.S. will become a net chemical importer by 1990 are not uncommon, he says.

However, Loos disputes these doom-and-gloom reports. "The U.S. positive balance of trade in chemicals is not in jeopardy," he told a meeting of the Chemical Marketing & Economics Division.

He points out that chemical trade has shown remarkable stability and resilience over the years. He believes that most foreign trade is based on sound, long-term business needs. And, although U.S. exports of some commodity chemicals certainly will shrink as new producers enter international markets, Loos expects this loss to be more than offset by increasing U.S. exports of more technically advanced, higher value-added chemical products.

According to Loos, pessimistic attitudes about the future of U.S. chemical trade are based on several well-publicized factors:

- The shrinking U.S. energy and feedstock cost advantage.
- Increased competition from energy-rich nations, in which governments do not always respond to the profit motive.
- Chronic, worldwide overcapacity in many chemicals, particularly in basic petrochemicals.
- Stagnant industrial and economic growth.
- The strength of the U.S. dollar.

Each of these arguments is reasonable, says Loos. However, they lose force when viewed in the broader context of a global industry. For instance, Western Europe had a significantly worse feedstock position than the U.S. between 1973 and 1980, yet its chemical exports grew faster than those from the U.S. Countering other arguments, Loos says that the emerging competition from energy-rich nations will come from a very narrow product spectrum that includes mostly C_1 and C_2 commodity chemicals.

Leading U.S. exported chemicals remain fairly constant

	1982		1980	
	Rank	Value ($ millions)	Rank	Value ($ millions)
Diammonium phosphate	1	$ 679	1	$1096
Low-density polyethylene	2	417	2	505
Phosphoric acid	3	407	9	281
High-density polyethylene	4	323	5	297
Polypropylene	5	286	6	287
Styrene	6	276	3	389
Acrylonitrile	7	248	—	120
Catalysts	8	236	10	239
p-Xylene	9	226	11	221
Polyester fiber	10	226	7	142
Urea	11	22?	4	312
Polyvinyl chloride	12	171	12	192
TOTAL		$3726		$4061

Source: A. D. Little Inc.

He believes that meanwhile chronic worldwide overcapacity could turn into chronic shortages in a period of economic recovery. This is particularly true because of the large amount of basic petrochemical capacity already shut down or scheduled to be shut down and the cancellation of several large international petrochemical projects.

Nor is the dollar's strength a new problem for U.S. exporters. The hangup is that, after the spectacular rise in U.S. chemical exports between 1976 and 1980, many trade analysts find it hard to accept old, established trade relationships.

Loos says that, contrary to what many think, chemical foreign trade is not a "single entity." Instead, it involves several distinct types of trade. One of these is technological trade, the most logical of all trade. One country exports a single chemical that is not produced in the importing country, often because of a technological advantage.

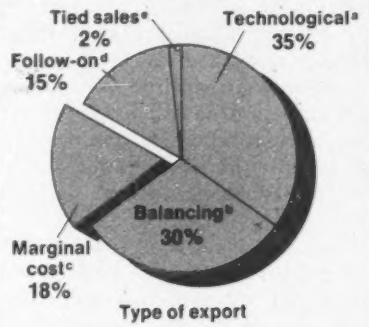
Balancing trade refers to supply-demand imbalances between countries or a company's international production system. This type of trade often occurs because of the large scale of new chemical plants compared to market growth and often involves fast-growing chemical commodities.

Follow-on trade occurs as companies expand their international operations, marketing their entire product line in a foreign country through exports even though only a few of their products are produced there.

Another type of trade is marginal cost trade. This is the most disruptive type of trade to market conditions in importing countries. When operating rates are low, companies seek export markets at less than full market price. This trade often leads to worldwide price cutting, unprofitability, and dumping.

In addition to these types of trade, tied sales can involve long-term barter agreements or compensation deals.

Marginal cost exports are small share of total exports



a Depends on specialized proprietary technology. b Corrects imbalances between supply and demand. c Exports at less than full market price. d Occurs as companies expand their international operations. e Related to long-term barter agreements on compensation contracts.
Source: A. D. Little Inc.

Unfortunately, says Loos, marginal cost trade gets most of the publicity. And it is this trade that forms the basis for many pessimistic forecasts about the U.S. chemical trade future.

However, marginal cost trade accounts for only 18% of U.S. chemical export volume, technological trade commands 35% of exports, and balancing trade chips in with another 30%.

Even in marginal cost trade, there is more than meets the eye, says Loos. For instance, synthetic resins are a large export item that trade pessimists cite as a sure loser to new international competition. But Loos points out that, although the low-value, major thermoplastics accounted for 60% of resin export volume last year, much higher-value specialty resins accounted for 65% of the value.

Forecasting the future of U.S. chemical exports is not easy. Each type of foreign trade responds differently to changes in the economic cycle. Individual chemical exports may fit into more than one type of trade category. Fluctuations in currency values do have to be pumped into the equation.

In addition, chemical export growth is far from uniform. Between 1980 and 1982, the value of fertilizer exports dropped 39%, while that of medicinals and pharmaceuticals rose 18%.

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International

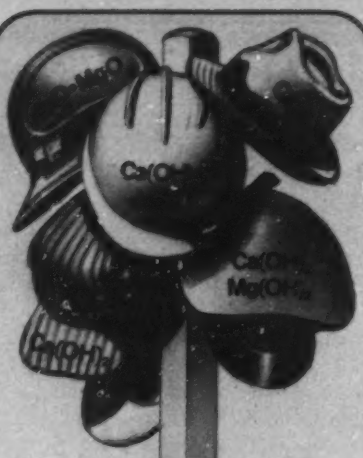
Loos says that a correlation exists between value-added and export performance. Products with high value-added indexes met or exceeded the industry's average export performance. Those with a low value-added index saw their exports decline significantly faster than the industry as a whole.

Even during the worldwide recession, Loos says, there were some bright spots in the U.S. chemical export portfolio. These bright spots, he adds, reflect the security of export markets that fit into the technological or follow-on trade categories.

To forecast future chemical trade trends, it helps to know which of today's leading chemical exports will be future winners and which will be losers. Arthur D. Little tries to determine its winners and losers with a chemical trade risk analysis matrix that it developed. The matrix uses two conventional components of risk analysis. One is exposure, or the amount of revenue at risk. The other is uncertainty, which Loos defines as the probability of a chemical losing export share to production outside the country.

Where a product is spotted on the matrix pretty much determines its future export potential, or lack of it. For instance, the C_1 and C_2 chemicals have high uncertainty and are likely to lose export share. C_3 chemicals, aromatics, phosphate fertilizers, and ethylene dichloride are among the products with a moderate degree of uncertainty. They probably will maintain their export strength, Loos says, although their major export markets may change. The more technologically advanced and complex chemicals, he says, have a secure position in the export market and are likely to grow. Catalysts are an outstanding example.

Based on this same matrix and 1982 chemical exports of $19.9 billion, Loos says that chemical exports representing 22% of that value probably will decline in the future. On the other hand, products amounting to 36% of that value look like winners with a good chance of export growth. That is why he doesn't consider the U.S. chemical trade balance to be in jeopardy, even though trade patterns of the past may give way to new patterns. □



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